

re:search

a journey of intellectual inquiry

university of north carolina **wilmington**



New 600 MHz NMR Spectrometer
permits novel experimental approaches –
accelerating discovery of the structure of
biomolecules previously beyond reach.

BOTH UNDERGRADUATE AND GRADUATE STUDENTS ARE CORE PARTICIPANTS IN UNCW RESEARCH

Often, much is made about the dichotomy between basic and applied research. In reality, there is not a dichotomy but a continuum. Even the most esoteric, pure research project – conducted with no practical objective other than expanding our knowledge – may have a significant and long-lasting impact on society. On the other end of the spectrum, faculty members and their students conduct contract research for outside entities with specific deliverables and tangible goals.

This issue of *re:search* highlights work being conducted along the entire range of this research continuum and focuses on some of the studies and projects that promise to make major contributions to the welfare of the region, state and beyond. Basic research on the migratory and breeding patterns of dolphins and whales crossed over into the realm of a human-interest story when the team filmed, for only the second time in history, the live birth of a right whale.

*University of North Carolina
Wilmington is a public
comprehensive university
dedicated to excellence in
teaching, scholarship, artistic
achievement and service.*

*The university seeks to
stimulate intellectual curiosity,
imagination, rational thinking
and thoughtful expression
in a broad range of disciplines
and professional fields.*

Involving undergraduate students in the research projects of our faculty is a hallmark of the UNCW learning experience. However, geology professor Patricia Kelley extended this opportunity to students from other institutions, who are underrepresented in the sciences. This was accomplished by means of a grant from the National Science Foundation to support Research Experiences for Undergraduates.

A number of research projects have obvious implications for the health of humans and domestic animals. Alison Taylor studies the basic biology of algae, but her work on the red tide dinoflagellate will have implications for understanding harmful algal blooms. Art Frampton and his graduate student, Laura Singletary, study novel receptors in viruses. Their work has a direct application to the development of an anti-viral drug for the prevention of equine herpes virus (EHV-1).

Construction has just been completed on our new oyster hatchery. Under the leadership of Ami Wilbur, research on the genetics and larval development of oysters will be used by UNCW scientists and others in the state to increase the oyster populations and ensure the health of this important fishery. Work has also begun on the marine biotechnology building. Supported in part by a \$15 million grant from the National Institute of Technology Standards, this building will be the first for CREST, UNCW's millennial campus and will support research collaborations between MARBIONC and the private sector.

On the truly applied end of the spectrum, Carrie Clements and Rich Ogle are developing an online intervention package to prevent and mitigate the development of post-traumatic stress disorder in active duty military. Jeff Ertzberger has developed and is marketing an online game to assist teachers in engaging students as they learn vocabulary, math and critical thinking skills.

These are just some of the exciting research projects featured in this issue of *re:search*. All of these stories exemplify the role that UNCW faculty and students play in expanding our knowledge of the world and helping its inhabitants.



UNCW/JAMIE MONCRIEF

Robert D. Roer



re:search a journey
of intellectual inquiry
to explore or examine
in order to discover

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{ table of **contents** }



12



18

12 ACCELERATING DISCOVERY

A new Bruker 600 MHz Nuclear Magnetic Resonance (NMR) spectrometer and more than \$2 million of state-of-the-art equipment support research projects in the Department of Chemistry and Biochemistry. In 2009-10, 96 undergraduate and graduate students were involved directly in this research, learning to carry out the most sophisticated experiments – training that cannot be replicated in either the traditional classroom or laboratory settings.

by Kim Proukou '06M
Lindsay Key '11MFA

FEATURES

18 TINY BUT DEADLY

Department of Biology and Marine Biology associate professor Alison Taylor collaborates with scientists at UNCW's Center for Marine Science and researchers in the United Kingdom to conduct interdisciplinary investigations of the cell biology of marine phytoplankton that poison animals and humans. The cellular basis for this toxicity remains to be resolved.

by Lindsay Key '11MFA

24 A PARTNERSHIP OF LAW AND SCIENCE

Robert H. Cutting Jr., associate professor of environmental studies, and professor of biology Larry B. Cahoon are at the forefront of the debate over climate change. In a groundbreaking article, published in the *Vermont Journal of Law*, Cutting and Cahoon argue that invisible invasions are also trespass and therefore subject to the same private property protections.

by Kim Proukou '06M

20 THE RACE TO STOP EHV-1

Equine herpes virus (EHV-1) is a major threat to horse populations worldwide. With the number of cases increasing dramatically in recent years and the racing industry holding its breath, scientists like Art Frampton are working tirelessly to develop an anti-viral drug. This project has provided research experience for 24 undergraduate, honors and directed independent study students.

by Lindsay Key '11MFA

DEPARTMENTS

2 NEWS

4 STUDENT SPOTLIGHT

6 RESEARCH AND LEARNING

10 MEDIA SHELF: BOOKS,
CD RACKS AND FILMS

27 OUTREACH

29 SUSTAINABLE SEAS

AT BEM 2010



Tse-Lynn Loh far left

Marine biologists have long held that the association between the Caribbean Orange Icing Sponge, *Mycale laevis*, and reef-building corals is a classic example of mutualism: a relationship inherently beneficial to both, where each derives a survival-benefit.

However, UNCW graduate student **Tse-Lynn Loh's** research supports concerns that the mutualism and the rich diversity of such ecological relationships are not so fixed that human activity can't nullify these ancient contracts.

Loh's doctoral dissertation research determined that the apparent mutualism between Caribbean Orange Icing Sponge and corals only occurs when sponge-eating fishes keep the growth of the sponge in check. She cites examples where sponges encroach or overgrow corals only when fish, their natural predators, are removed by overfishing. Loh presented her research on interactive relationships among coral reef organisms at Benthic Ecology Meeting 2010.

Loh's and professor of biology Joseph R. Pawlik's research on the function and interaction between these organisms on Caribbean coral reefs was first published in the *Journal of Experimental Marine Biology and Ecology*, May 2009. ■

A PERMANENT HOME

by Lindsay Key '11MFA



Ornithologist Steve Emslie curates the birds in the collection.

UNCW's natural history collection of 25,000 fish, 25,000 plants, 18,000 mammals, 1,100 birds, 1,000 reptiles and amphibians and 1,000 algae specimens has been upgraded.

With funding from the National Science Foundation, the entire collection has been accommodated on the third floor of UNCW's Friday Hall. Other improvements include an online image database, a new assistant curator and increased opportunities for undergraduate and graduate students to hone curator skills.

Considered a major university asset, the new online database will serve local, national and global scientists by providing public information on the taxonomy, ecology, evolution and conservation of plant and animal species in North Carolina and the southeastern United States. Plus, "online imagery will limit damage to specimens by reducing the need for external loans, shipping and handling," professor of biology and marine biology **Steve Emslie** says.

Assistant curator **Brenda Wichmann** manages all components of the collection, which had been divided previously among the laboratories of more than eight university scientists. Additionally, for the first time, a frozen tissue collection is being developed.

At least eight undergraduate and three graduate students per year will work on cataloguing and databasing the collection, complementing classes in museum curation, taxonomy and systematic science offered in the Department of Biology and Marine Biology. These applied learning experiences prepare students for a range of careers in museums, conservation and education, information system management and science outreach. ■



The 39th annual **Benthic Ecology Meeting (BEM)**, organized by the **Department of Biology and Marine Biology**, was held on the campus of UNC Wilmington March 10-13, 2010. Sponsors included international academic publishers, developers and manufacturers of tools for environmental monitoring and testing, non-profit educational organizations, research societies, the American Academy of Underwater Sciences, the N.C. and S.C. Sea Grant Consortia, UNCW's Center for Marine Science, Division of Academic Affairs and Center for the Support of Undergraduate Research. Professor of biology **Joe Pawlik** served as chair of the conference. Total attendance was more than 700, including international participants. For the first time, BEM 2010 added a film festival at UNCW's Lumina Theater to the traditional proceedings. Professional, as well as amateur filmmakers, directors and students submitted film shorts related to marine biology/conservation.

RIGHT WHALE BIRTH

Photos taken under NOAA scientific Permit No. 948-1692 to UNCW

by Lindsay Key '11MFA

Observing the birth of a right whale in the North Atlantic is extremely rare. Catching it on a camera is nearly a miracle. But, on March 20, 2010, a team of UNCW and Duke University researchers observed a right whale birth off the coast of Jacksonville, Fla., and recorded the experience for only the second time in history.

Overseen by UNCW marine mammal experts Bill McLellan and Ann Pabst, team members Heather Foley and Richard Holt of Duke University with UNCW research specialist Peter Nilsson and UNCW marine mammal observer Rachel Hardee have been aerially surveying a stretch of water far off the Florida coast for the past year.

The project is part of a long-term marine mammal and sea turtle monitoring program for the U.S. Navy's proposed Undersea Warfare Training Range (US-WTR) in North Carolina and Florida. Following the Marine Mammal Protection Act of 1972 and the Endangered Species Act of 1973, the U.S. Navy is required to monitor areas prior to conducting anti-submarine warfare training.

Because the twin-engine planes used for monitoring are small, only two researchers and two pilots go out at once. On the day of the recorded birth, Foley and Holt were flying over an area of water about 50 miles offshore when they spotted a female right whale with a white mark across her fluke. Taught to inspect for signs of entanglement or ship strike in endangered species like right whales, the researchers flew to 750 feet for a closer look.

"They spent 18 minutes on top of the whale, documenting the white mark on the fluke," said McLellan. "But then, she

ended up going down on a long dive, which is unusual, because usually they are not feeding down there. Then, all of a sudden three clouds were expelled from the cow, which we recognized later as blood, and up popped a little animal on the side."

At first, Foley thought that a shark had attacked the whale. But after a few seconds, she and Holt realized the animal was too wrinkly to be a shark – it was a baby right whale! Circling the animals for another half hour, the researchers captured never-before-recorded footage of mom and calf bonding, including the calf's first breath and subsequent breathing patterns, or respiration rate. The images were the first start-to-finish account of a right whale birth. North Atlantic right whales are highly endangered, with a remaining population of only 400-450 individuals.

When fuel capacity necessitated that the team turn back, the Florida Fish and Wildlife Conservation Commission moved in to continue documentation. Using photos taken by the two aerial survey teams, the New England Aquarium later confirmed the female whale as "Derecha" #2360 in the North Atlantic Right Whale Catalog.

The birth is especially significant because it occurred outside of critical habitat waters; that is, the area where right whales were previously known to reside during

the winter calving months. While critical habitat waters are deemed as waters up to 35 miles off the coast, this birth was filmed 50 miles offshore. Indeed, the research team has spotted five right whales outside the critical habitat.

McLellan is excited about the survey project, now in its second year, because these are the most comprehensive data anyone has ever collected on the whereabouts of marine mammals and sea turtles far offshore of the southeast U.S. coast. Rather than just monitor during winter months, as is typically done in other survey projects, UNCW and Duke researchers will spend three complete years monitoring never-before surveyed water approximately 40 to 100 miles offshore. ■

"The data that the survey teams gather at these offshore sites have already enhanced our understanding of marine mammals and sea turtles," Pabst says. "In addition, these data will help inform important federal management and permitting decisions."



UNCW researchers photograph the first start-to-finish account of a right whale birth.

GRADUATE STUDENT PROFILE

by Lindsay Key '11MFA

Steve McMurray, a Ph.D. candidate in marine biology, was awarded the prestigious 2010 Walter B. Jones Memorial Award for Excellence in Coastal and Marine Graduate Study, June 2010, in Washington, D.C., and the Distinguished Master's Thesis Award in the Life Sciences at the 2010 annual meeting of the Conference of Southern Graduate Schools, February 2010, in Savannah, Ga.



In 2009, McMurray spent a year in Washington, D.C., as a John A. Knauss Marine Policy Fellow. The program matches highly qualified graduate students with hosts in the legislative and executive branches of government for a one-year paid fellowship to learn the importance of the relationship between good resource management and good resource policy. In the following interview, McMurray shares his experience with MFA graduate student Lindsay Key.

What were your duties as a Knauss fellow?

I served in the National Sea Grant Office as coordinator for Sea Grant's Safe and Sustainable Seafood Supply and Healthy Coastal Ecosystems focus teams. These focus teams are comprised of 10 to 12 nationally recognized experts who advise the National Sea Grant College. In this role, I helped facilitate Sea Grant activities and developed national initiatives and cooperative efforts among various partners. I also assisted with reviewing agency documents and legislation, coordinating a Sea Grant fishery catch shares workgroup, representing Sea Grant on various NOAA cross-agency workgroups, developing new initiatives for the NOAA budget process, serving on steering committees for national symposia planning and strategically planning how Sea Grant works to address climate change.

How did the fellowship enhance your understanding of your research interests?

It exposed me to the large array of emerging issues that NOAA and Sea Grant work to address and influenced me to ask questions on a larger ecological scale. For example, I learned a lot about ecosystem-based management and the importance of managing all components of an ecosystem collectively rather than individually.

What will you take away from the fellowship?

One aspect that strikes me the most is a better understanding and knowledge of the breadth and depth of the entities (academic, NGO, federal government, private sector) that work toward better management of our country's marine natural resources. Coming into the fellowship, I had no idea of the magnitude and diversity of the marine resource

management community and the roles and relationships that exist between the entities. It was good to learn that many of these folks are working hard to address our nation's most pressing marine resource issues.

Did the fellowship allow for new opportunities (resources, access, etc.)?

The experience made me eligible for a greater variety of jobs, within NOAA and the federal government and outside. It provided me access to a network of Knauss alumni and others across the federal agencies who manage our nation's marine resources. I am currently going back to school, but the experience provided me insight into applying for grants, connecting with appropriate collaborators and other opportunities for research, outreach and education as an academic that I otherwise may not have had.

In June 2010, you won the Walter B. Jones Memorial Award for Excellence in Coastal and Marine Graduate Study. Besides the obvious honor of winning the award, were there other perks?

A major perk was the opportunity to meet congressman Walter Jones Jr. He sat down with all the North Carolina winners for more than an hour. I was really impressed by his knowledge and genuine interest in addressing issues affecting the N.C. coast and the country. In addition to marine resource issues, we discussed many hot topic issues, including the war in Afghanistan and illegal immigration. Afterward, we took photos with him.

What were your thoughts upon receiving these awards?

I was really honored to be recognized among the other outstanding recipients. It was great to have the hard work that I put into my master's thesis recognized, and it has motivated me to set even higher expectations and goals for my work as a Ph.D. student.

What's in the future in terms of your Ph.D. research?

As a master's student, I studied the demography of the giant barrel sponge *Xestospongia muta* in the Florida Keys and found that sponge populations may have important implications to the health and structure of coral reef communities. Recent research has furthered our understanding of the functional importance of sponges, indicating that they have the ability to significantly alter the chemistry of the water they filter. For my dissertation, I will study the implications of climate change and ocean acidification on coral reef sponge populations and how sponge populations may directly or indirectly influence the structure and dynamics of coral reef ecosystems. ■

Endnote: Steven McMurray '08 M.S. in marine biology developed the first technique for reattachment of large coral reef sponges, work that was featured with cover photo in the journal *Restoration Ecology*, March 2009, and is the first to establish the age of Caribbean Barrel Sponges at hundreds to thousands of years. His thesis work has been published in the journals *Marine Biology* and *Ecology*. McMurray is a Ph.D. candidate in marine biology studying with UNCW professors Christopher Finelli and Joseph Pawlik. Pawlik is second author of "A Novel Technique for Reattachment of Large Coral Reef Sponges," *Restoration Ecology*, Vol. 17, Issue 2.



UNCW/JAMIE MONCRIEF

About the Author, **Lindsay Key** will graduate with an M.F.A. in Creative Writing in Spring '11. A 2006 graduate of Virginia Tech, she has a degree in English and communication. A newspaper journalist for two years, at UNCW Key has served as content manager for UNCW Research Website and writer for *re:search* Magazine. Key plans to pursue a career in university publications.

UNDERGRADUATE PROFILE

by Kim Proukou '06M

Best teaching and assessment practices translate into higher student achievement. By defining learning goals, providing applied learning experiences and training students in both traditional theories as well as emerging issues in their fields – UNCW prepares its students for 21st century success.

In addition, **Lucas Borton**, a first-generation college student, is very proud of his parents for paving his way by good example. "My father, he is a cop back home. He was in the Marine Corps for 20 years, retired and is now a police lieutenant in Havelock, N.C. He wanted to be a cop since he was my age, and I just followed in his dream. I've always been very respectful of that."

Borton will continue that dream armed with two majors: sociology and criminology – essentially two degrees. Borton's positive experience and successful career at UNCW is due in great part to an exceptional faculty investment.

For more than four years, the sociology and criminology faculty

and 21 other departments in the College of Arts and Sciences have worked to identify and promote learning outcomes in each of their disciplines that seniors must successfully demonstrate in order to graduate.

The 100-, 200- and 300-level courses on Borton's transcript were carefully designed to provide him with the skills necessary to understand, apply and analyze social phenomena as well as methods used by social scientists to explain and interpret sociological events, topics and problems. For his second major, Borton applied the same rigor to understanding criminal activity, criminal corrections, crime control and criminal court procedures. His two majors required that he demonstrate mastery of four years of theory and methods courses – in each area – as well as finish two 400-level capstone courses. ■

What are his plans now?

Borton says, "I want to go back home, and I'm kind of up in the air between military service and doing basic law enforcement training. Eventually, I would like to get a federal job." When asked what kind of federal job, he replied, "ATF, FBI; I want to go one step above my father."



OUT OF THE CLASSROOM INTO THE FIELD: RESEARCH EXPERIENCES FOR UNDERGRADUATES

by Kim Proukou '06M



PHOTOS BY UNCW/CARLTON WILKINSON

UNCW professor of geology **Patricia Kelley** (upper right) and **Gregory Dietl**, director of collections at the Paleontological Research Institution and adjunct assistant professor in the Department of Earth and Atmospheric Sciences at Cornell University (below left), received funding for UNCW's first REU, "Research Experiences for Undergraduates in Biodiversity," a three-year program, summer 2007-10.



Each year, undergraduates from across the country apply to Research Experiences for Undergraduates (REU) programs, funded by the National Science Foundation.

Here, visiting students collect and identify samples from field work in order to develop research proposals back at their home institutions.

A Scientific Rediscovery

A marl pit in Acme, N.C., actively mined in the early 20th century for fertilizer, had been "in the historical scientific literature for the past 100 years," according to Dietl. However, in recent years, the once-famous fossil site disappeared from the literature, its location becoming unknown and its fossils assumed to be depleted.

However, the marl pit had not disappeared from the memory of local residents. One Sunday, Kelley, whose husband is pastor of the Acme Presbyterian Church, discovered that a member of the congregation, who hunts in the area, was familiar with the pit – now on the property of Oak-Bark Corporation.

The Less-Traveled Road to Discovery

On June 16, I went along on the first 2010 REU group trip to the Acme site. After the 30-minute drive to Route 87, we turned down Fertilizer Road, where Kelley's contact, Pete Yurgel, directed us down a less-traveled, old dirt road. We parked, then walked through wild grasses and brush to begin our descent down a slick leaf-covered slope to the area where Kelley promised the marl pit. As the woods became thicker, the descent steeper, we clung to branches to steady ourselves, carefully making our way down until, in the dappled light, the pit appeared – a still, small pond in the midst of a thick, undisturbed wood.

I looked up and to the right and there was Dietl, standing on a narrow ledge and pointing to an exposed cliff packed with shells, perhaps thousands of them, embedded as surely as if the ocean had just deposited them.

"Two million years ago, this was the ocean," Dietl says. "That is why the shells are here. When the sea level was higher, all this was underwater. In the Pleistocene Epoch, Raleigh was oceanfront."

“Everyone thought the site was gone, that there were no fossils left in that area,” says **Christy Visaggi**, a doctoral candidate in the Department of Biology and Marine Biology and student mentor for the REU.

“So, to re-find a site we thought had been lost was really exciting. And, then to find that it had such an abundance of awesome material so well preserved!” Several students chose some aspect of the site to include in their individual projects. “They actually went back to Acme several more times...just to collect and collect.”



Methods and Objectives

From June through July, for three years, a select, diverse cohort of nine senior and junior undergraduates from across the nation have come to UNCW to study critical issues of biodiversity loss. Comparing fossil, archeological and modern marine samples, they sought to understand how the Southeastern coastal marine ecosystem has changed over time – as well as the role of human activity in that change.

The Acme site is but one of about a dozen North Carolina fossil localities REU faculty, mentors and students investigated. Referencing geohistorical data, students ascertained levels of human-induced biodiversity loss and ecosystem change by comparing the fossil record to modern conditions.

Key to the program’s success was its objective of learning research by doing research. Student researchers considered which questions to pursue, identified their methods, did literature reviews to see what is currently known, wrote research proposals, then conducted original research and presented their results.

Interdisciplinary and Diverse

Undergraduates with majors in fields such as archeology, biology, geology and environmental studies used their diverse backgrounds to share knowledge and ignite discussion of the possible causes and degrees of biodiversity loss and ecosystem change from the Pliocene Epoch, three million years ago, to present time.

Recruitment efforts for the REU included colleges and universities across the nation with large minority populations.

The variety of disciplines represented encouraged collaboration; racioethnic diversity encouraged creativity and expanded perspectives.

Records Etched in Shell

Students focused on marine mollusks (clams and snails), which play key roles in most shallow marine ecosystems today, are abundant as fossils and can provide an environmental record – historically etched in shell.

Dynamic systems do change, but Dietl says that today, “We are changing conditions at a rate that is not sustainable. We are removing predators and changing ecosystems.” According to Dietl, mollusks are good indicators of environmental conditions, showing “how diverse and healthy the ecosystem is, or was.” Their shells bear predation marks that provide evidence of ecosystem structure in the past; growth bands within the shell can be sampled and, with mass spectrometry techniques, will yield temperature records and ecological data – such as life span and growth rates – that can demonstrate how ecosystems are, or have been, affected by environmental conditions.

Reaching Goals

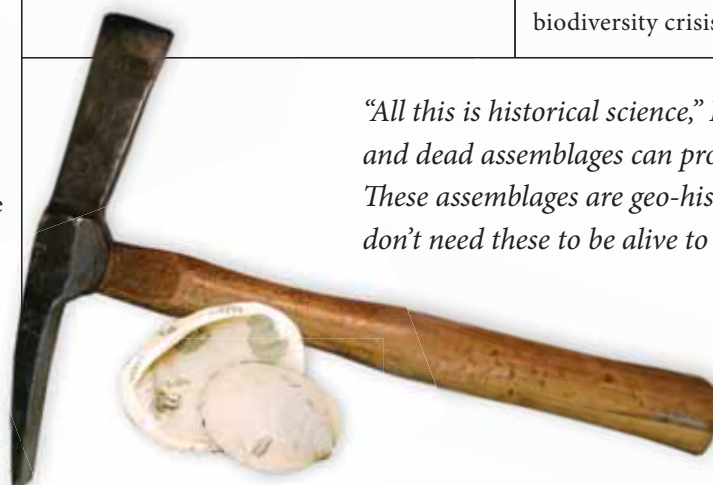
Students present individual and group projects at the annual meeting of the Southeastern Section of the Geological Society of America each spring. More than two dozen presentations have been given from REU years one and two. Most REU participants from the first two years have been accepted to graduate school or are employed in science-related positions. First-year REU student Steve Durham of Dartmouth University had his first paper accepted for publication by



Left to right: UNCW doctoral candidate in marine biology Christy Visaggi and professor of geology Patricia Kelley examine an outcrop.

Palaeogeography, Palaeoclimatology, Paleoecology, an important international journal for the geosciences, commonly referred to as “P-Cubed.”

With the third summer concluded, Kelley says, “This program has achieved its objectives. We’ve started more than two dozen students on their way to careers in science. Along the way, they’ve conducted research that will be an important contribution to the scientific literature. And, they’ve learned and experienced the value of multidisciplinary collaboration that will be essential to solving the current biodiversity crisis.” ■



“All this is historical science,” Dietl says. “Both live and dead assemblages can provide historical data. These assemblages are geo-historical data...you don’t need these to be alive to tell you things.”

GAMES THAT TEACH

by Lindsay Key '11MFA

Reaching every student is a principal challenge for teachers juggling the demands of overcrowded classrooms, ambitious course requirements and limited budgets. But one quality Net generation students share is a love for video games.

At uncw.edu/EdGames, a website created by UNCW education professor **Jeff Ertzberger**, students and teachers can download vocabulary, math and critical thinking skill-building computer games that engage students of all abilities in active learning.

Created in Microsoft Office Word, PowerPoint and Excel, these games are compatible with most basic computer operating systems; many are free and easily edited to complement specific course material.

Ertzberger's game, "Big Board," similar to the TV game show *Jeopardy*, allows teachers to plug in questions. In "Sunken Treasure," similar to "Battleship," students' correct answers create opportunities to guess which on-screen box holds treasure.

In 2009, Ertzberger launched LevelUp Learning, an educational technology company in which UNCW owns intellectual property rights. Ertzberger also markets

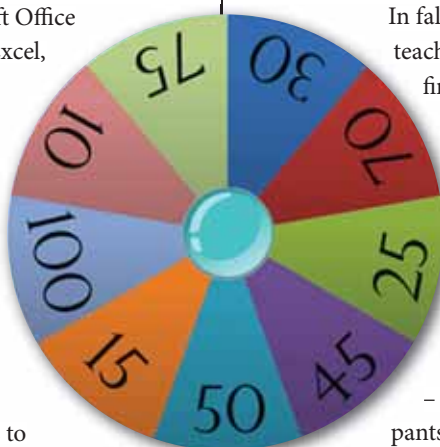
EdGames website as well as the textbook he authored, *Everybody Wins: A Teacher's Guide to Customizing Games for Any Curriculum*.

In the textbook, Ertzberger synthesizes decades of research on the impact of using technology in the classroom.

In fall 2007, he surveyed 390 teachers from five counties, finding that expense, amount of time to create, relevance to curriculum and lack of technology deter teachers from using video games in the classroom. "The study found that an overwhelmingly majority – 94 percent of all participants," he says, "would

be willing to try video games if templates were available that they could modify to match their curriculum."

"When Dr. Ertzberger approached the Office of Technology Transfer for assistance, we quickly saw multiple opportunities for UNCW and for him," says **Christy Shannon**, UNCW's technology transfer specialist. "This effort supports an individual faculty effort and creates a new local company."



The Big Board

When a teacher purchases the \$30 textbook on the EdGames site, he or she also obtains rights to download a selection of video games in addition to the ones available at no charge.

"We are targeting school systems, districts and community educational centers to sell site licenses for multiple classroom and teacher use," Shannon says. "For individual purchases, we are relying primarily on internet marketing."

During the first six months of 2010, the website received almost 125,000 visitors. The most popular game, "Big Board," was downloaded approximately 13,000 times during that period.

Ashley Smith, a fifth-grade teacher at Tramway Elementary in Lee County, owns Ertzberger's textbook and uses the video games and other game templates to review content for quizzes and tests in spelling, social studies and language arts subjects. "My students absolutely love it," Smith says. "They are totally engaged with the learning more so than a lecture format or any traditional presentation of material." ■



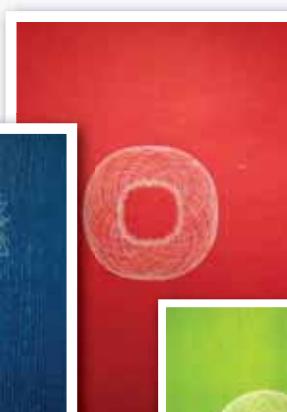
"I had used a PowerPoint Jeopardy game with my high school students and was amazed at the level of engagement that a simple game created," Ertzberger says. "I wanted to see what else could be done with games."

Jeff Ertzberger holds an Ed.D. in technology education from Pepperdine University in Malibu, Calif. He worked as a teacher in Johnston County and for the N.C. Department of Public Instruction before coming to UNCW where he teaches instructional design and instructional technology. Christy Shannon is technology transfer specialist for UNCW's Office of Technology Transfer. She holds an MBA from UNCW's Cameron School of Business.

Westwood 5



Westwood 3



Westwood 6



SINGLE-LEAF WOODCUT

by Kim Proukou '06M

Department chair of art and art history **Ann Conner** employs two art forms expressed in wood: the woodcut – a relief against cuts that show as white against grain – and woodblock printing. Her favorite cuts are drawn with creative use of Spirograph® toys. With plastic triangles, rule-shaped bars, knotty gears and toothed rings in hand, Conner traces fine-lined curves and inspired shapes. For large images, she devised an extension arm for the toy.

When carving, Conner uses a high-speed Automach power chisel similar to a Dremel tool or laser to cut the block. “That doesn’t chew up the wood,” she says. “I try to disguise the cutting process so that it does not look handmade but carved as if by magic. The only clue I like to leave is the grain of wood.” Her six-block Brentwood series took more than a year to carve.

Understanding the woodcut as a composite of design, color, technique and integrated textures, Conner considers the grain of the wood an essential graphic element. Similarly, she prefers Japanese papers for their variety of strength, texture and luminosity.

In addition to museums and arts exhibits, Conner’s work is also purchased for commercial décor. Neiman Marcus, known for offering customers the finest designer choices, recently purchased eight woodcut prints for the entrance to their Atlanta store, and Fidelity Investments has purchased several sets.

The Westwood Suite is a study in white-line woodcut. Conner carves thin lines within larger areas of original surface that when printed will show color. Editing can mean at times adding or subtracting lines to create a sense of movement against the inked grain. “Sometimes the grain came out a bit different than I expected. Actually, it becomes a happy accident,” she says.

Conner’s use of fluorescents in the Westwood Suite is indicative of her signature: use of native woods, brilliant color, beautiful papers and expert mill cuts to create a novel integration of art and technique with whimsy in wood. ■

Conner’s work has been exhibited in national and international shows and collections. She has been listed in *Who’s Who in American Art*, *Who’s Who of American Women*, *Who’s Who in the South and Southwest* Silver 25th Edition as well as the *73rd Annual International Competition*, *Journal of the Print World*.

BOOKS, CD RACKS AND FILMS

Awards Flow for Two Hours in the Dark

Two Hours in the Dark is a little story that is attracting big audiences. This short film conveys the essence of Frank Capra at a time when immersion in randomly kind universes populated by caring strangers, loving families and loyal friends – Capraesque universes – might be considered naïve. Yet, 21st century audiences seem unable to get enough.

Since its first screening as a work-in-progress at the 14th annual Cucalorus Film Festival in November 2008, Hackler's "little story" has garnered a cascade of accolades: the Jury Award for Best Short at the Charleston International Film Festival, the Judges' Choice Award at the Alabama International Film Festival, the Fiction Juried Screening Award from the University Film and Video Association, Best Narrative from the Light Factory 2010 Filmmakers Showcase, Best Spiritual Film at the Breckenridge Festival of Film

and most recently, Best of Fest Award at the Route 66 International Film Festival.

New acceptances to the Napa Sonoma Wine Country Film Festival and the prestigious Rhode Island International Film Festival (RIIFF) bring more honors. RIIFF is considered one of the top 12 film festivals in the U.S. and is a qualifying festival for the Academy Award for "Best Short Film."

"It's about one of the greatest filmmakers ever, and this little story that changed everything"

"The film's about someone going through a personal crisis, and I think most people can relate to that, having gone through something similar themselves, or knowing someone who has."

— **Chip Hackler**, assistant professor of film studies

"I loved your film in every way."

— **Jerry Ziesmer**, first assistant director for the films *Apocalypse Now* and *Jerry Maguire* and Winner of the Director's Guild of America's Frank Capra Award



The Songs of Hollywood

by Philip Furia, *professor of creative writing*, and Laurie Patterson, *assistant professor of computer science* (Oxford University Press, 2010)

"If you love attractive songs and movies that sing and dance, this book is a must. But, be prepared to rent all the films you missed or will want to see again after reading the authors' appetizing descriptions!"

— **Lyricist Sheldon Harnick**

Fiddler on the Roof, She Loves Me, Fiorello!

After years of research, writing and editing and watching almost 2,000 musical films, Philip Furia and Laurie Patterson present a fascinating book of film study. Praised for its academic value as well as its readability, Furia and Patterson trace the use of music and dance from Hollywood's *The Jazz Singer*, in 1927, to the decline of film musicals in the mid-to-late 20th century. Furia and Patterson leave us eager to watch these national treasures again, and, as they say, keep "the closest thing we have to a vital repertoire of classical music" playing.



“This one’s a memorable gem.” — Jazziz

Composer, arranger and world-class trombonist, UNCW professor of music **Jerald Shynett** is on trombone for the album *The Comet’s Tail: Performing the Compositions of Michael Brecker*, a tribute to Brecker, jazz composer and saxophonist, who died in 2007. The recording is considered among the year’s best in jazz. The track “Slings and Arrows” was nominated for a 2010 Grammy Award.

A UNCW faculty member for 11 years, Shynett brings his professional expertise to the classroom. “I live in two worlds,” he says, “the academic world and the competitive world of performance.”



From Solidarity to Schisms: 9/11 and After in Fiction and Film from Outside the U.S.

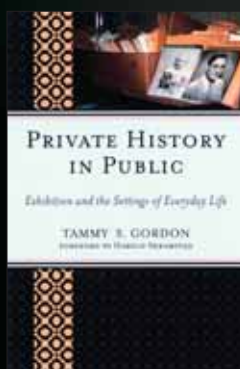
Cara Cilano, editor
associate professor of English
(Editions Rodopi, 2009)

“...this collection brings together critics whose essays perform reading as a critical act of remembering... as an act of survival.”

— **M. Karavanta,**
European Journal of American Studies

Editor Cara Cilano and international contributors expand discussion of the effects of Sept. 11, 2001, and its aftermath in critical essays of film and fiction. Essayists offer fresh perspectives of the dichotomies, economic downturns, cultural rancor and violence following 9/11, suggesting that within these very anxieties and polarizations, lie real opportunities to effect positive change.

“The artists wanted to see 9/11 as an opportunity for people to engage meaningfully,” Cilano says. “As horrific as the event was, they saw hope.”



Private History in Public: Exhibition and the Settings of Everyday Life

by Tammy S. Gordon
assistant professor of history
(AltaMira Press, 2010)

“Tammy Gordon is an engaging guide through a world of historical exhibitions that remain mostly unrecognized by professional public historians...”

— **Benjamin Filene,**
University of North Carolina, Greensboro

Tammy Gordon explores exhibits beyond professional history museums investigating the wellspring of small community museums and private local exhibits in churches, curiosity shops, restaurants and bars, at visitor centers and other public spaces. She emphasizes that both forms of display - public and private - together form a combined record of memory, feeling and belief that connects individual perspectives to national and political history in surprising ways.

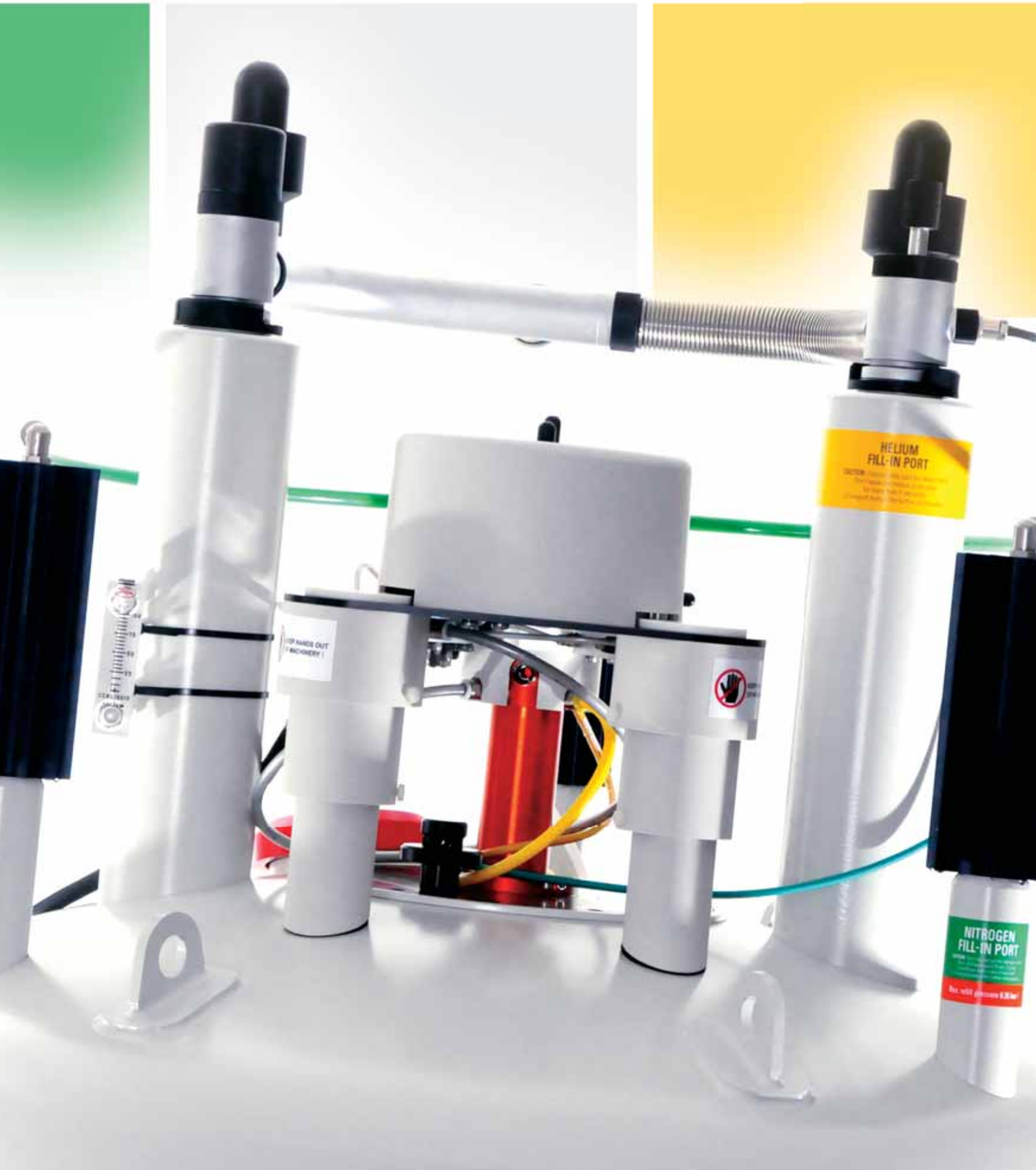


The Lost Rocks: The Dare Stones and the Unsolved Mystery of Sir Walter Raleigh's Lost Colony

by David La Vere
professor of history
(Dram Tree Books, 2010)

David La Vere’s novel-like read examines one of the great puzzles of American history. While doing research for an appearance on the History Channel’s TV series *Digging for the Truth*, La Vere became fascinated with the Dare Stones – 48 etched stones, found during the 1930s, alleged to reveal the fate of Sir Walter Raleigh’s Lost Colony. After thorough analysis, La Vere maintains that 47 of the stones are forgeries, but the authenticity of the first Dare Stone found near the Chowan River has yet to be discredited. “The language is Elizabethan,” La Vere says. “It meshes with the primary sources, and it tells a plausible story.”

Contributing writer and editor
Sarah Onyshko'12



ACCELERATING DISCOVERY



By Kim Proukou '06M and Lindsay Key '11MFA

A \$700,000 grant from the National Science Foundation has enabled UNCW's Department of Chemistry and Biochemistry to acquire a 600 MHz nuclear magnetic resonance (NMR) spectrometer. It permits researchers to investigate the nature and effects of chemical interactions more accurately and with greater sensitivity.

The new NMR was required to fulfill current and future research and teaching needs. It will augment the department's aging 400 MHz NMR and will be used not only by chemistry and biochemistry faculty but also by biology faculty and researchers at the Center for Marine Science.

Now, UNCW researchers and their students have access to the new NMR and to new differential scanning and isothermal calorimeters that augment more than \$2 million of sophisticated experimental and computational chemistry department resources, including electrochemical analyzers, a gas chromato-

graph-mass spectrometer (GC-MS), ultra-violet-visible (UV-VIS) spectrophotometers, Fourier Transform infrared (FTIR), fluorescence, optical emission and atomic absorption spectrometers, gas and liquid chromatographs, and soon, two Liquid Chromatography Mass Spectrometry (LC-MS) systems.

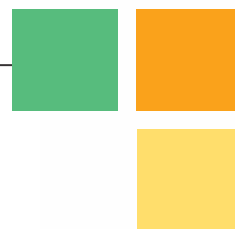
The new and existing facilities will accelerate discovery for researchers and give graduate and undergraduate students access to state-of-the-art instrumentation to apply their learning and advance their research skills.

Experiment in Progress

All matter has chemical properties, but each molecule is unique. Chemists continuously solve fresh puzzles by recognizing patterns, collecting and mining large data sets to reveal molecular structure. Nuclear Magnetic Resonance (NMR) techniques yield important pieces of structural information that allow researchers to propose molecular function. Information about form and function is key to the efficient design of new drugs and drug delivery systems as well as many other applications.

Three 600 MHz NMR Research Projects:

- Ligand design with targeted cell specificity for cancer drug delivery
- Investigation of lipid membranes and protein interactions for the development of polypeptide antibiotics and therapeutic drug delivery systems
- Analysis of rain water composition for the presence of contaminants and pollutants



Associate professor of chemistry Sridhar Varadarajan prepares a sample in a thin-walled NMR glass tube.

These three projects seek answers to questions such as, “How can anti-cancer drugs be delivered to specific sites?” “What peptide-based drug delivery design will best carry antibiotics and toxic molecules to targeted cells?” and “What rains back on us?”

The Ties that Bind: Ligands*

**a molecule or group which binds to another (usually macromolecule) with a high degree of specificity.*

Ligands could be called the middle linebackers of therapeutic drug delivery – opposing advancing cancers and other seemingly intractable diseases. Using NMR technology to read the molecular structure of DNA, associate professor of chemistry **Sridhar Varadarajan** designs ligands to deliver knock-out drugs to rapidly growing cancers. His research is also applicable to the treatment of autoimmune diseases such as juvenile diabetes.

Cancer: A Moving Target

“Cancer is really a number of diseases – multiple things have to go wrong in a cell for it to become cancerous,” Varadarajan says. “Each cancer has to be addressed differently. Good cell-targeting ligands must bear enough complementarity to their targets to be accepted by cancer cells. Good DNA-binding ligands must bind to specific sites on the DNA within these cancer cells to deliver the lethal blow.”

The diversity of types of cancer as well as the variety of possible targets and outcomes makes ligand design for drug delivery a very sophisticated task.

“We are testing compounds that can target cancer cells with pure DNA,” Varadarajan says, “and if these compounds bind to DNA and cause damage where we need it, we can destroy the cancer cell without harming healthy cells.”

Current DNA-damaging drugs used for cancer chemotherapy do damage to both normal and cancerous cells. While this damage kills the cancer cell, damage done to normal cells can sometimes lead to mutations, which can cause secondary cancers. Also, the damage experienced by rapid-growing normal cells leads to chemotherapy side effects such as hair-loss and gastric irritation.

Varadarajan has identified an agent Me-lex (1) that efficiently kills cells. He is attaching cell-targeting ligands to this agent so it can be delivered selectively and efficiently to only cancer cells. Most importantly, even if Me-lex should enter normal cells, it will not cause mutations.

These drugs, currently being developed in the Varadarajan lab, have the potential to minimize side effects of cancer chemotherapy while effectively eliminating the occurrence of secondary cancers.

“Me-lex achieves its remarkable selectivity due to its design, the product of years of collaborative work, and places the damage within a particular groove of DNA at specific sequences,” Varadarajan says.

However, Me-lex lacks “tissue specificity” and needs assistance in recognizing cancer cells. Varadarajan, his colleagues and students are attempting to design a ligand able to recognize, in this case, breast cancer cells, and deliver the drug to destroy only the tumor.

“We are attempting to confer tissue-specificity to Me-lex by tethering it to cell-targeting ligands that can bind to a unique receptor or protein on the target cell,” he says.

What NMR Technology Can Do

The 600 MHz NMR, with its larger magnet, offers better resolution and more detailed spectra – graphic read-outs of peaks and ridges – that signify distinguishing chemical shifts and other properties. These spectra reveal the structure of proteins and nucleic acids key to successful ligand design. The technology also gives researchers information on the binding strength of a potential ligand-DNA interaction.

“The sensitivity and dispersion afforded by the 600 MHz NMR, which provides enhanced carbon (^{13}C) sensitivity, is critical for this work,” Varadarajan says.

Host Defense Peptides*: The Almeida Labs

**Peptides are chemically identical to proteins, but much shorter in length and much simpler in three-dimensional structure.*

From the common cold to altered gene expressions, peptides are on the frontlines in the fight against disease. According to assistant professor of chemistry **Antje Almeida**, “Most living beings have evolved a primary defense mechanism directed at invading or competing organisms. The molecules that constitute these defensive systems tend to be simple peptides – or small proteins – that are often target-specific for a particular organism.”

Understanding these host peptide defense mechanisms is essential to the design of antimicrobial drugs. Antimicrobial is a general term for a group of drugs that includes antibiotics, antiviral medications and drugs to combat parasitic diseases. Because today’s microbes have become resistant to older drugs, and new challenges from infection are on the rise, antimicrobial research is very important.

In collaboration with the lab of **Paulo Almeida**, Antje Almeida and her students study peptides to better design new, antimicrobial drugs against which microorganisms will find it harder to develop resistance.

“Understanding the exact binding interactions between the ligands and DNA is critical to the successful development of this class of DNA-damaging drugs,” Varadarajan says.



Structure and Function

For example, defensins, antimicrobial peptides with innate immunity, are excellent host-defenders. They are found in vertebrates, invertebrates and even plants. Well named, defensins protect by thwarting invading bacteria and provide other protections as well, promoting wound healing – even reducing inflammation. Defensins could be prototypes of highly effective drugs.

While their properties are not completely understood, it is clear antimicrobial peptides are able to cause the death of tumor cells and microorganisms by interacting with the plasma membranes of invading cells and/or bacteria. The Almeidas' research is yielding important information that will help to explain how defensins and other antimicrobial and cell-destroying peptides move across bacterial cell membranes.

The National Institutes of Health (NIH) funded Antje Almeida's research on the impact of bacterial membrane structure on peptide activity, earlier this year.

"All of the peptides studied have to interact with the plasma membrane of the target organism to either enter the cell or somehow disrupt membrane integrity," Antje Almeida says. It is "mysterious how the lipid composition of plasma membranes modulates the activity of these antimicrobial peptides." Solving that mystery may soon be within reach.

Improving Results

With the ability to manage both structure and function of new host-defense peptides, tailored-to-fit cargo-delivery systems can be designed to deliver therapies across cell membranes.

NMR Facilities Manager Emmanouil Chatzakis has extensive experience with high resolution NMR instrumentation. Here, he explains the circuitry of the NMR to undergraduate honors student Zekaria Saleh.

Professor of chemistry Pamela J. Seaton oversaw the installation of the new 600 MHz NMR spectrometer. She and Chatzakis trained faculty and students in NMR processing and analysis capabilities.

PHOTOS BY UNCW/CARLTON WILKINSON

Two research efforts under the direction of associate professor of chemistry Paulo Almeida have been granted ongoing funding from NIH and Research Corporation for Science Advancement for more than five years. Both undergraduate and graduate student support is provided on each of these projects.

The first effort, funded by the NIH, seeks to understand the structure and function of three types of peptides: anti-microbials, cytolytic peptides and CCPs, cell-penetrating peptides, also called protein transduction domains. Understanding their functions – for example, interacting with the membranes of cells and lipid vesicles and disrupting them – is a first step in the design of new therapeutic drugs and/or cargo-delivery systems.

The second project focuses on lipid membranes and is funded by Research Corporation. Lipid bilayers are the major components in biological membranes.

Results from both projects have been presented at international meetings and published in top professional journals, with master's and undergraduate students as co-authors.

Protein NMR Spectroscopy

The technology available from advances in NMR spectroscopy, particularly three-dimensional imagery, is essential for studying smaller proteins and peptides.

Cellular etiquette is strict. The design of a drug that cells will accept is as important as the composition of the therapy itself. Efficient design for delivery requires understanding of the behaviors of both the peptide and the receiving cell membrane on the target.

The Bruker 600MHz NMR allows the Almeida labs to test new peptides for “transduction” – that is – the transfer of material to target cells that will permit these cells to recognize and/or accept delivered therapies. Maximizing the potential of cell-penetrating peptides or CPPs is a primary focus of the Almeida's research.

“The idea is to exploit the target specificity of these peptides in the design of new antibiotics or vehicles to carry drugs or macromolecules into specific cell types,” Paulo Almeida says.

What Rains Down on Us?

Atmospheric Chemistry

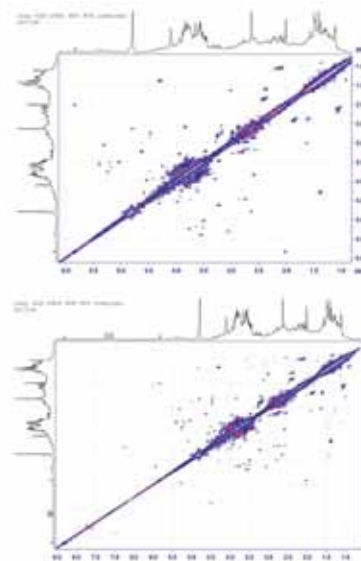
A complex mixture of chemical compounds, rainwater includes organic acids, sugars and metal ions in trace amounts evasive to detection with older technology. However, even trace amounts of harmful chemicals can build up over time. Now, with the ultra-sensitivity and high resolution of the 600 MHz NMR spectrometer, members of UNCW's Marine Atmospheric Chemistry Research Laboratory (MACRL) can pinpoint these materials and potentially determine their source.

“The technology will allow us to perform more sophisticated NMR experiments which give two- and three-dimensional images of the mixture of compounds in rains, enabling us to identify individual chemicals,” says professor of chemistry and biochemistry **Pamela Seaton**. For example, in the case of sugar molecules in rainwater, scientists will be able to determine whether the molecule is table sugar, a plant sugar, bacterial sugar or some other type.

Chemical changes are evident in NMR spectra. Scientists analyze the spectra of rainwater for patterns that might lead to a better understanding of atmospheric processes. They do experiments with rainwater that mimic atmospheric processes to understand chemical reactions; for example, how sunlight changes the components of rain. With the 600 MHz NMR these studies can be done more quickly – accomplishing in 16 hours what the older, lower-powered 400 MHz NMR took 60 hours to do.

In a broad sense, the unknown compounds identified by the new 600MHz NMR will help in understanding processes involved in the burning of fossil fuels.

“The more we know about what's in the atmosphere, the better equipped we will be to understand environmental problems, like what might be impacting global warming,” Seaton says.



Two-dimensional spectra plots guide chemists in a way somewhat similar to a music score. When a molecule is lowered into a NMR's magnetic field, radio waves pummel the nuclei. Under the barrage, the nuclei spin differently, creating resonance, analogous to “song.” Researchers read the spectra produced from a completed experiment in much the same way a talented musician might read shifts in octave as variations of theme unfold. In this case, structural variations and chemical shifts reveal the structure and potential function and/or impact of a compound or molecule.

MACRL researchers are experts in analytical chemistry, NMR spectrometry, sediment chemistry, marine organic chemistry, potential impacts of global warming and sea level rise, trace metal speciation in estuarine and atmospheric waters, photochemically mediated processes that impact environmental systems as well as the fate of pharmaceutical and personal care products in the marine environment. The team includes 11 graduate students and six-to-12 undergraduate research students per year. In addition to Seaton, core members are professors **Joan Willey, Robert Kieber, Brooks Avery, Ralph Mead** and **Steve Skrabal**. ■

“The more we know about what's in the atmosphere, the better equipped we will be to understand environmental problems, like what might be impacting global warming,” Seaton says.

Tiny but deadly

Karenia brevis' method for poisoning

by Lindsay Key '11MFA



UNCW/CARLTON WILKINSON

For decades, scientists have been puzzled as to how and why some microscopic marine phytoplankton produce specialized neurotoxins that poison animals and humans. UNCW associate professor of biology and marine biology **Alison Taylor** has set out to answer these questions by investigating the effects of the Florida dinoflagellate *Karenia brevis* and other algae responsible for harmful algal blooms (HABs).

Grazed upon by other neighboring planktonic species in nutrient-rich coastal waters, dinoflagellates are a type of algae. Smaller than the diameter of a human hair, these water-dwelling unicellular organisms exhibit an array of morphological and physiological traits. Some may emit light through bioluminescence, the same process by which fireflies glow, and most are photosynthetic using the sun's energy to produce food, thereby playing a critical role in marine ecosystems.

Yet under the right conditions, a few species can cause HABs that result in devastating ecological and economic damage in coastal regions because of the neurotoxins they produce. Such HABs are known colloquially as red tides, because the pigments of these organisms discolor the water a pinkish-reddish hue.

While HABs have been known to occur naturally since the 18th century, according to the National Oceanic and Atmospheric Administration (NOAA), outbreaks are increasing in both frequency and severity. It is estimated that along the coastlines and in the surface waters of the United States, a single HAB event can cost as much as \$60 million in lost fisheries and recreational economic activity in affected communities. To respond to an increasing environmental threat and human health risk from HABs, the U.S. Congress passed a law in 1998 requiring NOAA to lead an inter-agency task force on HABs and provide continually funded research into the origins and types of organisms that cause them.

Because dinoflagellates are microscopic marine plants, it is curious that they make neurotoxins which can adversely affect humans and other mammals that do not share their environment or evolutionary history. Interestingly, Taylor's team discovered several non-toxic phytoplankton that exhibit properties similar to animal nerve cells, including membrane ion channels which enable them to generate nerve-like impulses. Because *Karenia brevis* competes with nontoxic phytoplankton for resources, it is possible it may have evolved channel-specific poisons to target planktonic prey or competitors as a mechanism of self-defense.

"As soon as we saw these nerve-like impulses in non-toxic marine phytoplankton, my first thought was this could be an ecologically relevant target for algal neurotoxins," Taylor says.

With the microscopy lab's current laser-based confocal microscope, **Sheila Kitchen**, a marine biology graduate student working with Taylor, has determined the distribution of toxins

and fluorescent markers within non-toxic phytoplankton cells. Using this technology, Kitchen can scan a thin section and, by focusing through the cell in steps, reconstruct a three-dimensional image of the cell and spatial location of the markers. "Her research in the last two years has really moved this work along," Taylor says. "Sheila's thesis research verified the localization of certain toxins within the cell and, using electrophysiology, demonstrated an effect on the fast signaling events of the membrane."

Taylor developed a National Science Foundation grant proposal to support further research into the interaction of toxins with ion channels in other species of plankton. The proposal, funded this year, supported the purchase of new microscope imaging equipment essential for the study of the cell signaling patterns associated with the phytoplankton nerve-like impulses.

The new advanced microscope with EMCCD (electron multiplying charge coupled device)-based live cell imaging – a fast and ultra-sensitive digital camera technology – will enable real-time capture of the cellular events that underlie rapid cell signaling in both *Karenia* and non-toxic species. This increased capability will permit an unprecedented view of the subcellular activities that underlie behavior and the ability of these cells to sense their environment.

"What we are doing," Taylor explains, "is using light to interrogate live cells."

Taylor, who is originally from the UK, joins UNCW's collaborative team of HAB researchers in the departments of biology and marine biology, chemistry and biochemistry and at the Center of Marine Science who have been studying *Karenia brevis* and its name-bearing toxin, *brevetoxin*, for more than 12 years.



Sheila Kitchen

brevetoxin, for more than 12 years. Center for Marine Science director Daniel Baden and CMS researchers have collected extensive background and exposure data to indicate that brevetoxins elicit neurotoxic, immunologic and pulmonary effects in models of humans and animals exposed to brevetoxin by inhalation. Effects can be potentially fatal when humans consume contaminated shellfish, resulting in neurotoxic shellfish poisoning, a serious condition of the central nervous system that also hinders ability to breathe.

"Collaboration with HAB researchers here on campus and at the Center for Marine Science, together with our long-standing international link with scientists in the UK, provides an excellent platform with which to develop this exciting new interdisciplinary research program," Taylor says. "New imaging equipment provided by NSF will complement imaging equipment already available to faculty, graduate and undergraduate students and significantly extend our high-resolution live-cell imaging capabilities at UNCW." ■

UNCW/CARLTON WILKINSON

It is estimated that along the coastlines and in the surface waters of the United States, a single HAB event can cost as much as \$60 million in lost fisheries and recreational economic activity in affected communities.

The **RACE** to STOP EHV-1

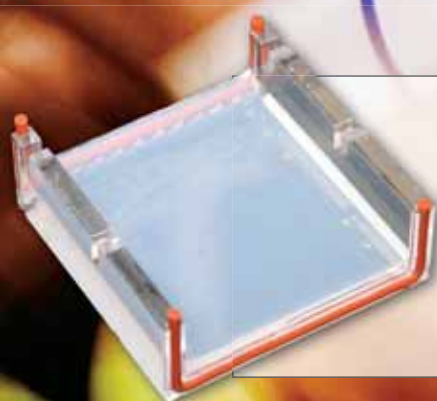
by Lindsay Key '11MFA

A virologist's collaboration with marine science researchers could block the horse virus





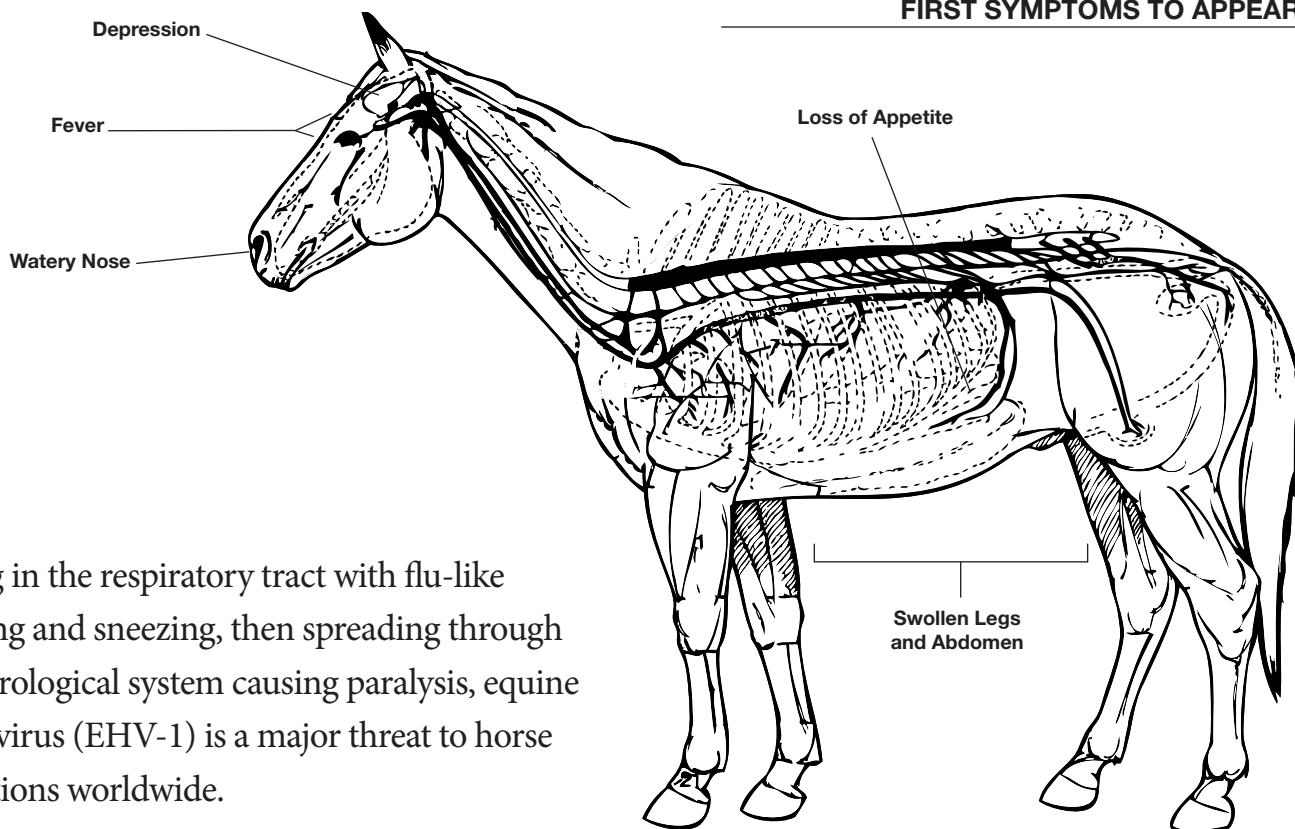
“If we can generate drug-resistant viruses, we might be able to go in and sequence those and see where the mutations in the virus are occurring. That might clue us into where and how the drug is acting.” – Art Frampton



Gel Casting Tray for Agarose Gel Electrophoresis of DNA

Agarose gel electrophoresis is the simplest way to separate and analyze DNA. A plasmid – a small circular strand of DNA – is loaded into the top of the gel, and an electric current is run through it. DNA will migrate towards the positive electrode and separate by size.

FIRST SYMPTOMS TO APPEAR



Starting in the respiratory tract with flu-like coughing and sneezing, then spreading through the neurological system causing paralysis, equine herpes virus (EHV-1) is a major threat to horse populations worldwide.

Fever, depression, watery nose, loss of appetite and swollen legs and abdomen are the first symptoms to appear. As the disease spreads, some horses experience incontinence and the inability to stand. Pregnant mares are very susceptible to the virus, which can easily invade the sensitive endometrium surrounding a fetus and deprive the unborn foal of oxygen resulting in a stillbirth or weak foal that dies within days of birth.

Spread by direct contact with nasal secretions of infected horses through shared feed, water, buckets, blankets, tack and equipment or from the hands, boots or clothes of handlers, the virus is triggered continually for the rest of the horse's life. Recurrences strike most commonly when the horse has a compromised immune system or is stressed by excessive heat, long transport to race or show, or new stable or pasture mates.

With the number of cases increasing dramatically in recent years and the racing industry holding its breath, scientists like UNCW virologist **Art Frampton** are working tirelessly to develop an anti-viral drug. Previously developed vaccines created to prevent the infection have proved weak and short-lasting.

Frampton's approach is novel and two fold: provide appropriate surveillance measures to detect an outbreak of EHV-1 in a horse stable or farm, and, if EHV-1 is confirmed, administer an anti-viral drug to limit the spread of the virus. While the current anti-viral drugs won't prevent infection, they will stop the spread of the disease through the equine body.

Blocking the Virus

In developing their research, Frampton and his laboratory team have a superior advantage at UNCW. At their fingertips are unique compounds from marine microalgae and cyanobacteria, isolated and purified by UNCW Center for Marine Science (CMS) chemists. Available to all UNCW faculty and members of the outside scientific community through collaborative studies and interactions, this collection contains thousands of compounds isolated from photosynthetic and non-photosynthetic marine organisms.

"What we have here is a library of organisms that have never been examined by anybody in detail in terms of chemical constituents and their biological properties," says Carl B. Brown Distinguished Professor

of Marine Science **Jeffrey Wright**, a bioorganic chemist at CMS.

Thanks to this one-of-a-kind collaboration and resource opportunity, Frampton received 480 chemical fractions - compound mixtures - from CMS researchers that he and his undergraduate students tested for their potential effectiveness in blocking the life cycle of EHV-1. Of these, one was found to be the best compound because it blocks virus replication while remaining non-toxic to the cell. Frampton and his students will continue to study this compound on a basic cellular level to determine how it blocks the virus.

According to Wright, this novel compound is produced by a photosynthetic dinoflagellate, a type of microalgae found in the ocean. Though some dinoflagellate species are toxic, other types produce non-toxic compounds, which may be beneficial for treating disease.

This discovery is just one example of several notable bioactive compounds found in Wright's lab, including potential antibacterial and anticancer agents.

"If we can generate drug-resistant viruses, we might be able to go in and sequence those and see where the mutations in the virus are



Graduate student Lauren Singletary examines cell cultures in a biosafety cabinet that provides a sterile environment for cell-based assays.



Assistant professor of biology Arthur Frampton cuts a stretch of DNA with restriction enzymes to get specific-size fragments for cloning.

occurring. That might clue us into where and how the drug is acting,” Frampton says.

If this marine compound works, it could stop EHV-1 from spreading past the respiratory tract into an infected horse’s neurological or reproductive system, where it can do much more damage.

Human Applications: Fighting Cancer

Frampton’s EHV-1 research could have another use: cancer treatment. The human herpes simplex virus (HSV) has been shown to kill human cancer cells, but serious complications, like encephalitis - a swelling of the brain - remain a concern. Frampton’s hypothesis is that EHV-1, if used as a localized treatment in surgery, could kill human brain tumor cells with few side effects. His research shows that in tissue culture, EHV-1 can efficiently infect, replicate in and lyse, or kill, human brain tumor cells.

“We are genetically engineering the virus so that it only latches onto and infects the tumor cells while sparing the normal brain tissue,” Frampton says.

Currently funded by the Grayson-Jockey Club Research Foundation, Frampton is

seeking further funding to expand his EHV-1 study into the realm of cancer research.

This ongoing EHV-1 research project has provided opportunities for more than 24 undergraduates - honors and directed independent study students - to participate in world-class viral research. Undergraduates are intimately involved in every aspect of the EHV-1 projects, from experimental design, running assays, collecting and analyzing data to co-authoring results for publication in scientific journals.

Directed independent study students **Brian Kurtz '10** and **Sean Kelly '10** serve as first and third authors and graduate student **Lauren Singletary** (see sidebar) as second author of an article describing how the novel entry receptor MHCI was discovered. The article, “*Equus caballus* Major Histocompatibility Complex Class I is an Entry Receptor for Equine Herpesvirus Type 1,” was published in the *Journal of Virology* 84 (Sept. 2010): 9027-9034. ■

{ leading research }

Novel Receptor

How does EHV-1 invade a horse cell?



Lauren Singletary

Frampton and graduate student **Lauren Singletary** have identified a novel receptor, MHC class I (MHCI) - a portion of a horse cell that the virus uses as an entrance. Found in human and animal cells, MHCI normally aids the immune response system.

When EHV-1 enters a horse cell via MHCI, it is able to replicate, spread and cause disease. Clinical signs of infection, such as fever, coughing, nasal discharge and neurological disease can show up within 24 hours after virus entry, but typically the incubation period is four to six days.

In addition to identifying which receptor the virus uses to enter the cell, Singletary and Frampton are working to determine which viral molecules attach to the receptor to permit virus entry.

“The virus particles of EHV-1 contain 13 different glycoproteins on the surface. These are special sugar-protein molecules that specifically interact with receptors to allow entry into the cell. I am trying to figure out which glycoproteins are binding to our receptor,” Singletary says. “Once I can determine that, I want to go further to find out specifically which part of the protein is binding to which part of the receptor.”

Singletary uses an enzyme immunoassay, a biochemical technique that detects the presence of an antibody or an antigen in a sample. She coats laboratory plates with cells that possess the MHCI receptor as well as those that do not. Then, she coats the cells with glycoprotein D (gD), known to initiate entry in many strains of herpes virus.

“If it does interact with the receptor, then it should stick to the cells that have MHCI and not to the other ones,” she explains.

INVISIBLE A PARTNERSHIP OF LAW AND SCIENCE INVISIBLE

BY KIM PROUKOU '06M

The article “The Gift That Keeps on Giving: Global Warming Meets the Common Law,” clarifies issues at stake in the debate over climate change, arguably the most important controversy of the 21st century.



Together again at the forefront of education, environmental law and science, attorney, former prosecutor and associate professor of environmental studies **Robert H. Cutting Jr.** and **Lawrence B. Cahoon**, oceanographer, climate scientist and professor of biology, have published a groundbreaking article in the nation's leading environmental law journal, the *Vermont Journal of Environmental Law* (10 VJEL 109. 2008-2009). VJEL is an open-access, online and print journal that provides an international forum for investigation of environmental issues.

The Invisible Problem

In "The Gift That Keeps on Giving," Cutting and Cahoon address greenhouse gas emissions and other invisible pollutants, current understandings of common law nuisance and trespass, asking – has the law kept up with science?

Traditionally, courts recognize visible materials that cross property lines as a trespass – a frisbee thrown through the air, for example – regardless of whether or not harm occurs. This is a straightforward objective test that is designed to protect private property.

Yet regularly, the courts consider invisible pollutants merely a nuisance. "The nuisance standard is subjective, compared with the spatial test of trespass," Cahoon says. Also, nuisance violations require proof of damages. In the case of environmental pollutants, such harm can take years to discover – by then, often too late to rectify even if those affected have the means to pursue the case.

Cutting counters that "the visibility test is bogus, because science tells us some of the most dangerous pollutants are invisible. Trespass better reconciles the law with current science and economics because the test is spatial and objective. Trespass more accurately addresses the effects of all pollutants, even if they can be described only in equations," he says.

Cutting and Cahoon argue for revitalizing common law trespass as a remedial tool when national policy and statutory remedies fail to motivate and educate "to prevent serious environmental consequences to real people and places like the coast." Cutting and Cahoon have argued in top environmental

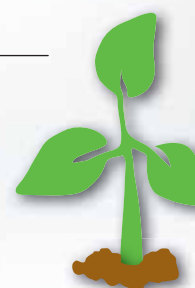
law journals that landowners own everything above and below their property lines, from the sky to the depths, and that an invasion, whether visible or invisible, is *trespass*.

Cahoon explains, "Scientifically, there is no question what's going on. The invisibility distinction is no longer relevant." Physical science can demonstrate that otherwise invisible agents are, indeed, present. For example, in the case of oil pollution detection, he says, "We look for oil-specific polynucleated aromatic hydrocarbons (PAHs). PAHs are invisible pollutants, some of which are potent cancer-causing agents and poisons."

The BP Oil Spill: Visible and Invisible

In the case of the BP oil spill disaster, the public can grasp visible oil pollution and its results. Yet, when toxic crude oil is rendered invisible by dispersants – or dissolves throughout the water column – it can eliminate much of the public relations problem, but certainly not the actual, if temporarily invisible, environmental damage.

Indeed, the invisible effects of the spill may turn out to be worse than the visible plumes and tar balls, particularly as BP races to clean up with dispersants like Corexit. The June 11, 2010, issue of *The Week* quotes Reese Halter of *The Atlanta Journal-Constitution*, "BP has used an unprecedented 700,000 gallons or more of Corexit, a chemical oil dispersant that's toxic to marine life." In addition, "the microbes that feed on oil are sucking oxygen out of the water, 'creating oxygen depletion zones' where nothing thrives."



A History of Environmental Leadership

Cutting and Cahoon have a history of effective environmental advocacy. In 1994, they combined efforts to address the problems of hog waste in eastern North Carolina. Two years later, Cahoon would appear on CBS' *60 Minutes* to defend their position that hog raising in large-scale piggeries could no longer be considered "farming," but rather, factory-mode, industrial production and, as such, should be subject to reasonable environmental regulations. The issue persisted. Cutting and Cahoon contributed to legislative solutions, and in 2003, CBS re-ran the segment with updates.

At UNCW, in 1998, Cutting and Cahoon developed a policy-relevant forensic environmental science course. Based on real cases, the course incorporates up-to-date methods of environmental investigation with current and emerging legal and scientific issues that inspired the article, "Ecology 101: Forensic Environmental Science, Where Laws and Ecological Principles Meet," published in the *Bulletin of the Ecological Society of America*, March 2006.

Invisible Global Warming and Greenhouse Gases

Invisible greenhouse gases (GHGs) are accumulating in Earth's atmosphere at ever-increasing levels. Yet, GHGs are also subject to nuisance law, and under nuisance, it is the receptors (those affected) by pollution that must bear the burden of discovering and proving damages.

Cutting and Cahoon argue that the property rights of the receptors of pollution are at least as great as those who pollute for free. Those who pollute should have to quantify what they generate and pay the true costs of disposal as well as damages. Under trespass law, they would. In an online Wilmington *StarNews* article, June 2008, Cutting and Cahoon asked, "Is protecting the economic interest of generators sufficient to overcome the impact on receptors?" Is it?

Why the Courts?

In the article, "If the Tide Is Rising, Who Pays for the Ark?" published in *The Coastal Society TCS Bulletin* Vol 32 (2) April 7, 2010, Cutting and Cahoon answer their question, "Why the courts?"

"The courts can resuscitate the common law to protect private property," Cutting says. While political stakeholders heavily influence the executive and legislative branches with strong, competing interests, Cutting and Cahoon say, that "the courts are uniquely well-equipped to take evidence, and then

reach objective, factual and legal conclusions." Once liability is found, the courts can use creative devices such as continuing supervision, special masters, interim damages, bonding and injunction to assess real damages and apportion responsibility.

Holding Back the Tide with Common Law

The common law concept of trespass provides a worldview that blends traditional property rights with the scientific realities of pollutant transport. Invisible pollution is, indeed, the "gift" that keeps on giving, damaging natural resources and private and public property – raising both tides and costs. Citing Working Group I, Intergovernmental Panel on Climate Change, *Climate Change 2007: "The Physical Science Basis"* 512 (2007) and other studies - as well as pending litigation - Cutting and Cahoon demonstrate that to ignore or deny the reality of GHG pollution and its effect on global warming is to invite catastrophe, "trillions of dollars in health effects; loss of property, crops and species and national security."

By ignoring the very real costs of doing nothing, they say, polluters have been given significant incentive to pollute, currently discharging gases into the air and dumping invisible pollutants into watersheds, estuaries and oceans largely without investigation, for free.

Such use of public and private property, air and water for disposal – without payment for either use or damages – not only passes far greater expenses into the future but increases health hazards as well.

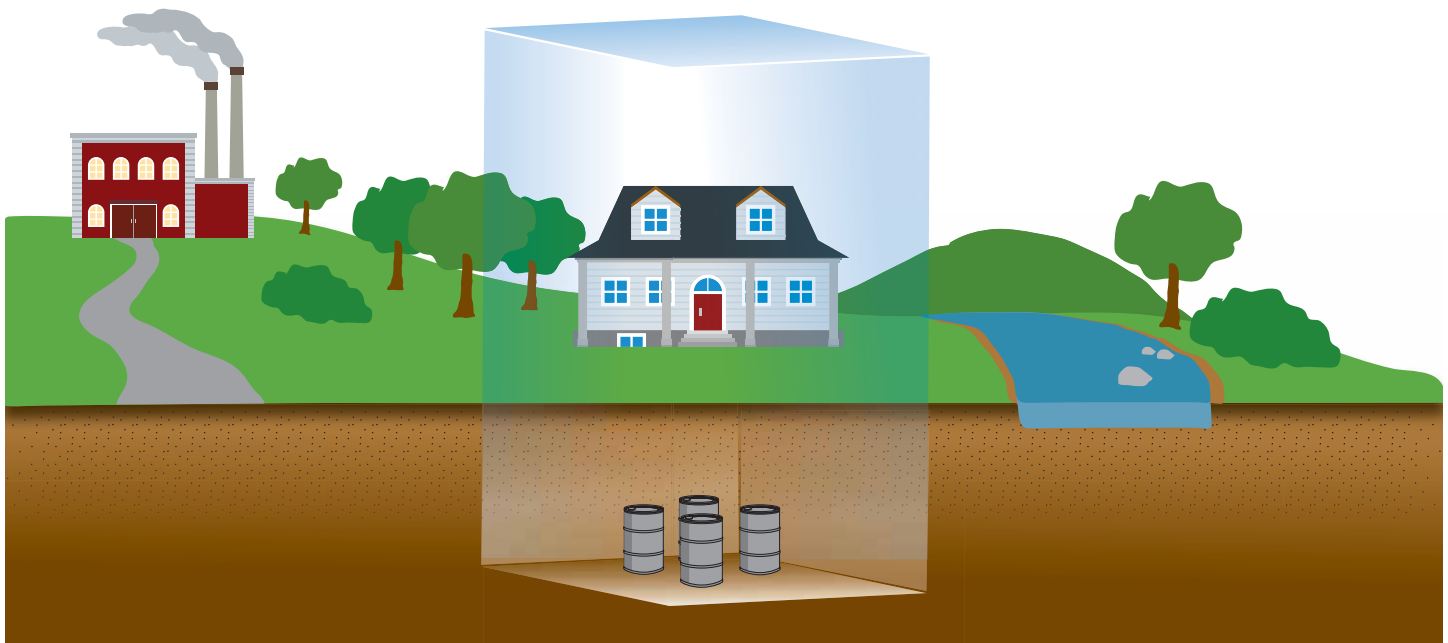
Giving Ear to Evidence

Recently, the U.S. Court of Appeals upheld public nuisance actions against generators of some 10 percent of the CO₂ emissions derived from human activities, clearing the way for a trial featuring the most current scientific evidence of the association between invisible GHG production and effects of global warming.

Cutting says, "We argue that invisible invasions of resulting heat, for example, also constitute trespass. It will rival the *Scopes Monkey trial*. Causation is there." ■

"Property rights are a three-dimensional concept, protecting subsurface, surface and airspace rights."

— Robert H. Cutting, J.D.



Concept by Shane Baptista, Illustration by Kyle Prey

PTSD: MORE BEFORE DEPLOYMENT

By Kim Proukou '06 MA

There is no celebration when war comes home, moves in and overtakes the soul, rages across the mind. Nightmares; restlessness; unwarranted, intrusive flashbacks; unease and fear; when war comes home, there is no peace.



Richard Ogle and Caroline Clements

UNCW/CARLTON WILKINSON



Professor of psychology **Caroline Clements** and **Richard Ogle**, associate professor of psychology, first began to develop therapies to treat post-traumatic stress disorder (PTSD) symptoms. But **Beth A. Barton**, UNCW military liaison and director of the Onslow Extension Program, helped them realize that “service members needed a stress inoculation component prior to deployment.”

Retired Marine Corps Col. **George W. “Bill” Ayers**, a member of the UNCW social work faculty assigned full-time to the Onslow Extension at Camp Lejeune, agreed.

Ayers, a former professor of neuropsychiatry and behavioral science at the University of South Carolina School of Medicine with a long career in public mental health, brought not only knowledge of post-traumatic stress disorder but experience “creating and implementing a stress inoculation program, at the request of a three-star general during Desert Storm, in theatre,” Barton says.

Soon they were a team – Ayers, Barton, Clements and Ogle on a new mission: prevention.

“No Marine,” Ayers says, “who has been on active duty for at least four years, has deployed less than two times. Some have

deployed as many as seven times. However, the critical variable is how long they are home before they go again. Dwell time (the time between deployments) should be a 2 to 1 ratio; for example, seven months out and 14 months at home.” For Marines, currently, dwell time is around 1.5 months.

“The bottom line,” Ayers says, “is that unless you have deployed, or are married to someone who has deployed, you really cannot understand deployments.”

Barton’s contribution allowed project ideas to develop naturally from within the real world of military personnel and their families in a culturally consistent manner. As military liaison for UNCW, Barton has close working relationships with command leadership at Marine Corps Base Camp Lejeune and Air Station New River, particularly the commanding generals of II Marine Expeditionary Force (MEF); Marine Corps Installations East (MCIE); and Marine Corps Special Operations Command (MARSOC). Clements brings a career-long interest in prevention, Ogle expertise in motivational interviewing, a self-directed, empowerment treatment basis.

Grass Roots, Boots-on-the-Ground Development

Ayers and Barton kept the researchers’ boots on the ground. Clements says, “Academics too often forget that in the real world, people do not want page after page of empirical justification. They want a program that works – in their culture and sensitive to its constraints.”

Early on, Clements and Ogle decided on telemedicine – the use of telephone and Internet technology – video, interactive messaging and online feedback, to make inquiry and information as private as a phone call or website.

Target: Prevention

According to Clements, “I don’t think anybody does this...that is, work specifically geared at prevention.”

“No, not in this way,” Ogle says. “We’ve got a lot of retrospective data on what people get PTSD, what they look like. We’ve got a lot of that. We don’t have a lot of this.”

“We will find out more about what are the particular risk factors...to develop even more precise prevention protocols,” Clements says.

Individuals will have the skills they need to face trauma and not become disabled as a result of their experience. “They can do their job, come home and resume their lives uninjured by their experience because they were given the skills needed to prevent stress injury before they were exposed to the stress in the first place,” Clements says.

“As a result,” Barton says, “we were privileged to present this telemedicine program to the UNCW Military Advisory Board, of which the commanding generals and officers are members. The response: wild enthusiasm!” ■

GRANT TO CARE FOR UNCW VICTIMS OF VIOLENCE

By William Davis '08 MA



Director of CARE Rebecca Caldwell and UNCW Police Capt. Gunnar Mathews receive Department of Justice grant to expand violence prevention programs and increase victim services on and off campus.

One of the university's seven strategic goals is to ensure that all members of the UNCW community can pursue their ambitions within a safe and secure environment.

Rebecca Caldwell directs UNCW's Crossroads and CARE programs that provide comprehensive substance abuse and education, resources for violence prevention, victim services, relationship education, counseling and programs to promote wellness and safety. Key to Caldwell's success has been her and her staff's ability to encourage modeling of values of respect, tolerance and concern, healthy living and safety by all citizens of the campus.

Now, a \$300,000 three-year grant from the U.S. Department of Justice Office on Violence against Women, co-written by principal investigators Caldwell and University Police Capt. **Gunnar Matthews**, will enable CARE (Collaboration for Assault Response and Education) and UNCW Police to take these accomplishments further.

CARE GRANT OBJECTIVES:

- Expanding prevention programs related to sexual assault, dating violence, interpersonal violence and/or domestic violence with support for a new victim advocate position.
- Increasing victim services to assist students to utilize resources for bringing disciplinary and/or other legal actions.
- Enhancing current successful services, protocols and policies.
- Promoting innovative collaborations among university administrators, campus police, local law enforcement agencies and community agencies that will enhance services not only on campus but in the wider community as well.
- Providing more educational programs designed to prevent stalking, dating violence, sexual assault and domestic violence.

Victim Advocacy

A new victim advocate position will provide immediate crisis response for victims of sexual assault, domestic and dating violence, and/or stalking – from incident to court and through follow-up. Twenty-four hour crisis response and advocacy, assistance at hospitals, on campus or at community police locations and counseling will make up 60 percent of the effort; 30 percent of the effort will be dedicated to campus education; 10 percent to community relations. The position description also includes chairing the campus Relationship Violence-Sexual Assault Response Team.



Adam Tate

Programs for Men

The grant will permit UNCW's already successful men's programs to expand, including the One in Four program, currently overseen by men's programs coordinator **Adam Tate**.

"The One in Four program," Tate says, "encourages male students to educate their peers about dating and interpersonal violence in a positive way, emphasizing how men can make a very positive difference in the prevention of violence."

Deriving its name from the troubling statistic that one in four college women will either survive rape or an attempt by their 21st birthday, One in Four is based on the research of professor John D. Foubert, who founded the program at the University of Virginia.

UNCW's program includes male student athletes, fraternity presidents, resident advisors and other male student leaders nominated by faculty and staff. After training, members serve as spokesmen and peer educators.

Grant Will Aid Law Enforcement and Others

The grant will allow UNCW Police to provide additional response training for campus and local police to address crimes of sexual assault and dating violence, including increasing danger to women from "club" and other predatory drugs.

Rape Aggression Defense (RAD), UNCW's popular self-defense classes offered by UNCW Police to students, staff and faculty, will receive much-needed new equipment and additional instructor training that will make it possible to offer advanced RAD classes.

UNCW's Division of Student Affairs and UNCW Police will be able to provide safety and security sessions as part of freshman and transfer student orientation for all students. University judicial boards will receive training in issues related to sexual and domestic violence and stalking; faculty and staff members will receive sensitivity training to be able to provide appropriate support and effective referral of victims. ■

Regional partners are Wilmington City and New Hanover County law enforcement, the District Attorney's Office, Coastal Horizons Rape Crisis Center, and Domestic Violence Shelter and Services Inc. of New Hanover County.

MARBIONC IS MARINE BIOTECHNOLOGY IN NORTH CAROLINA

Advancing health and quality of life by bridging the gap between discovery and delivery

BY LINDSAY KEY '11MFA



The MARBIONC building will be located northwest of UNCW's Center for Marine Science. Construction is expected to begin in late 2010 and continue through mid-2012.

Under the roof of a new two-story, 70,000-square-foot building, university and industry researchers, technicians and technologists will take food, energy and health solutions from investigation to innovation.

The facility, which will be connected to UNCW's Center for Marine Science by an enclosed bridge, will enable academic researchers and industry experts to consult on breaking scientific discoveries and develop applications in concert, cutting down speed-to-market time.

Marine Biotechnology in North Carolina (MARBIONC), UNCW's state-supported economic development program for marine biotechnology research and development, will occupy a portion of the labs and offices. Other space will be leased to public and private groups interested in developing natural marine-based products for a wide variety of uses.

The \$30 million building, partially funded by a federal American Recovery and Reinvestment Act matching grant, is expected to house more than 100 tenants from varying fields, including marine science, biochemistry, organic chemistry, law, business, immunology, mariculture and pharmacology.

Lab and office space will be organized by module, giving occupants the opportunity to rent more or less adjacent space easily. Each lab will be equipped with drop ceiling

utilities to optimize the building's modular floor plan, and geothermal heating and air will keep the building at a constant temperature conducive to sophisticated science.

Of further benefit is each tenant's close proximity to multiple CMS core facilities, including for example: DNA sequencing, nuclear magnetic resonance and mass spectroscopy, nutrient analysis, running seawater, stable isotope mass spectrometry, marine microorganism culture collections and more.

"The building was designed by scientists for scientists," says **Daniel Baden**, William R. Kenan Jr. Distinguished Professor of Marine Science and director of UNCW's Center for Marine Science.

Economic development opportunities spurred by business partnerships formed in this space should benefit the job market in Southeastern North Carolina.

"The building is expected to attract local, state, national and international organizations," says **Steve Fontana**, MARBIONC senior development technology officer. "For every new job that goes in the building, we are expected to create 1.5 to 2 new jobs in the community."

The field of marine biotechnology is expected to grow by more than 10 percent annually. Although terrestrial drug discovery is ongoing, it is only in recent years that scientists have turned to oceanic habitats

in search of natural products. With its exceptional research personnel, oceanic equipment and technology and prime East Coast location, UNCW is positioned to be a leader in the marine biotechnology field.

"With MARBIONC, we are seeking to answer the question of how to translate science into products helpful to society – how to move a discovery into industry where it is useful," says Baden. "Scientific research money comes from tax dollars, and federal and state agencies want to show what the public gets back for what we do."

MARBIONC's resources include cultured phytoplankton subclasses used to design drugs with enhanced pharmacological properties. Among them is *Karenia brevis*, a dinoflagellate with multiple potential pharmaceutical applications. Another novel marine compound, discovered by MARBIONC's director of research and Carl B. Brown Distinguished Professor of Marine Science **Jeffrey Wright**, is being evaluated as an antiviral drug (Reference on p. 22; story on p. 20). ■

MARBIONC research and development facility "designed by scientists for scientists" will translate discovery into development and deliver new pharmaceuticals, food sources, renewable energy technologies and environmental solutions from the sea – advancing the quality of life and sustaining economic development in the region.

Parties interested in partnering with UNCW and MARBIONC should contact Steve Fontana at 910.962.2330.



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New Shellfish Hatchery will Focus on Research and Education

A new 12,000-foot Shellfish Research Hatchery will allow associate professor of biology **Ami Wilbur**, fellow researchers and students to produce juvenile shellfish that are placed out in the wild. Research at the hatchery will foster the industry-produced oyster for food and also support restoration efforts. Wilbur, a shellfish geneticist, will direct the hatchery's mission of research, education and outreach.

Spawning oysters is a delicate task. An adequate water supply is critical to shellfish development, and water conditions must be continually supervised. "In a hatchery, we have to convince the shellfish to spawn," Wilbur says. "To do this we're basically going to mimic nature." Seawater systems will control

temperature, salinity, particle load and other parameters to imitate conditions "for whatever time of year we need," Wilbur says. "For example, we can mimic the natural conditions of late spring in February and thus mature the animals earlier than would occur in the wild."

Oysters spawn when rising water temperatures give them their cue. At the end of the larval stage they develop a foot to seek a settling place. It is thought that adult oysters may stimulate these very young oysters to "set." Once set, they are juveniles or "spat." The hatchery will provide researchers with the opportunity to investigate the role of genetics in the process of shellfish growth and survival. ■



The main culture room of the Shellfish Research Hatchery is equipped with tall, round larval culture tanks (rear) and rectangular "setting" tanks (forefront). Setting is the point at which swimming larva transition to juvenile "spat" until ready to be planted in the wild.

Aquaculture is the most rapidly growing sector of animal production. The ability to gain practical experience, in addition to the theoretical knowledge gained in the classroom, could translate into employment opportunities for UNCW students.

